Supplementary Materials

Figure S1 shows the calibration curves of MB at pH 8.

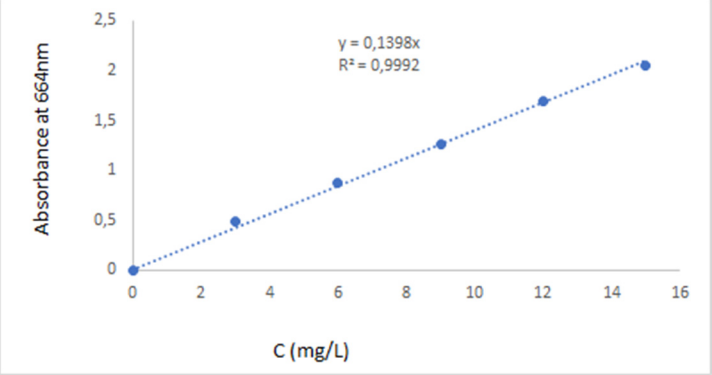


Figure 1. MB standard curve.

2.3.1. Carbonized Pretreatment

Fifty grams of dried algae (*U. lactuca*: UL-NA) were carbonization activated by heating at 600 °C in a high-performance electric Muffle Furnace (Shin Saeng Scientific Co., Ltd, SEF-301, KOREA) for 4 h with a flow of 30 mL min^{-1} at a heating rate of 5 C min^{-1}. The activated powder was then washed twice with double-ionized water in order to neutralize it (to keep the pH of the filtrate constant at a value of 7.0) and then dried in an oven (DEPATCH Oven Co) at 60 °C for 24 h. The active algal biomass obtained by the carbonization of dried algae was labeled UL-T.

2.3.2. Pretreatment with Chemical Reagent

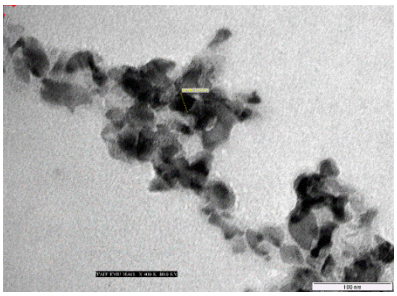
Fifty grams of dried algae (U. lactuca: UL-NA) were successively activated using concentrated H2SO4 (97%) or NaOH (97%). Stirring at room temperature using a rotary agitator at 200 rpm and for 24 h was then carried out on the various mixtures. The mixtures were then filtered, rinsed twice with double-ionized water to isolate the rest of the H2SO4 and NaOH, then neutralized with 0.1 M NaOH and 0.1 M HCl, respectively, to keep the pH of the filtrate constant at 7.0. The biomasses thus obtained were dried in an oven (DESPATCH Oven Co, LAC1-67-7, USA) at 60 °C for 24 h. The active algal biomasses obtained after the activation by H2SO4 and NaOH were, respectively, labeled UL-H and UL-OH for the dried seaweed. Non-activated biomass was used as positive control to compare the raw material of U. lactuca without any artificial modifications with modified carbon derived from U. lactuca. Furthermore, water insoluble substances remained after removing the hydrophilic substances were used as negative control to compare the strong activation methods carried out by strong alkali solution (97% NaOH) and strong acidic solution (97% H2SO4) with moderated activation method performed by water.

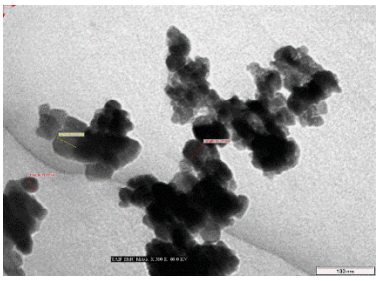
The activated materials generated by using 10 g of fresh thalli after activation (UL- WIS, UL-H, UL-OH, and UL-T) were measured and we got 36%, 52%, 42%, and 41.6% respectively along with 83% biomass of UL-NA, which indicated that activated biomass was not dissolved completely but mineralized and generated activated carbon. It must be mentioned that for logical comparison we used the same concentration of H2SO4 and NaOH to obtain UL-H and UL-OH respectively. Many studies used high concentration of H2SO4 as well as NaOH in addition to pyrolysis and heating at the same time

to generate activated carbon (Cazetta et al., 2011; Sultan et al., 2020; Tseng, 2006; Wahlström et al., 2020), whereas our study used only high concentration of NaOH or H2SO4 without applying heat or pyrolysis on the same treatments.

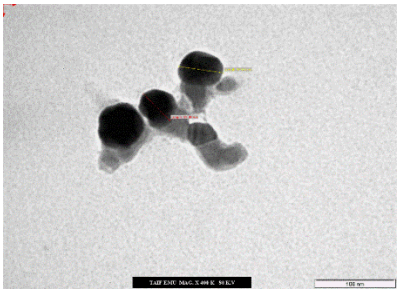
Figure S2 shows the TEM micrograph of raw dry U. lactuca (UL-NA), UL-WIS, and differently treated U. lactuca (UL-OH, UL-H, UL-T) before and after 75 min of contact with methylene blue at 1500 magnification.

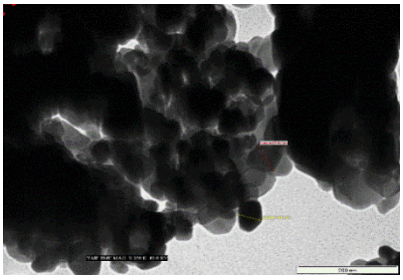
UL-NA



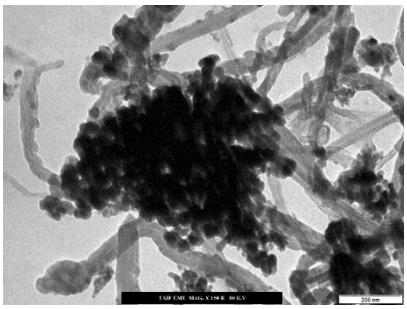


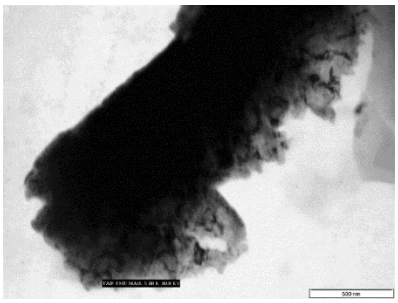
UL-WIS



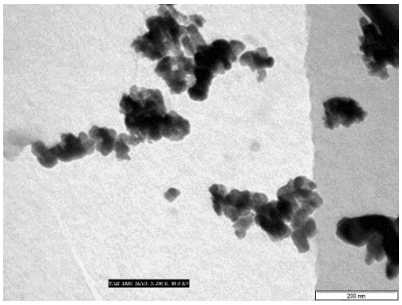


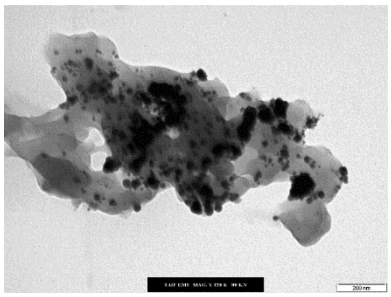
UL-OH





UL-H





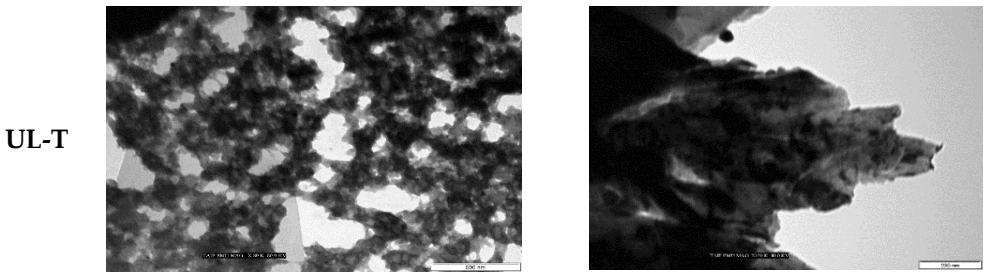


Figure 2. TEM micrograph of raw dry *U. lactuca* (UL-NA), UL-WIS, and differently treated *U. lactuca* (UL-OH, UL-H, UL-T) before (**a**) and after 75 min of contact with methylene blue (**b**) at 1500 magnification.

Table S1. Loss of mass of different biomass compared to the non-activated algae (UL-NA)

Yield%	Loss of mass%	Biomass
52.0	48.0	**UL-WIS**
36.0	64.0	**UL-OH**
42.0	58.0	**UL-H**
41.6	58,4	**UL-T**